Space Weather Technical Forecast

Issued on Friday, 04 March 2022 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storms. Slightly increasing chance of R1 Minor Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the period, with isolated C-class flares, the largest of which was a long duration C3.3 which peaked at 03/2155 UTC. This flare was emitted from AR2958, despite the region's small and innocuous appearance with a Bxo/beta classification and being barely visible. This region is one of six numbered regions on the disc; AR2954 and 2955 remain simple, mature and stable nearing the western solar horizon. AR2957 has reduced slightly, losing some penumbra. AR2959 is currently classified as the largest region on the visible disc, but AR2960 is likely to replace AR2959 as the largest and most complex region on the visible disc, once analysis becomes easier as AR2960 rotates further onto the visible disc. In addition a plage region has rotated onto the northeast limb, with flux loops showing in AIA 171 imagery indicating some complexity and energy available, despite the lack of visible spots. The long duration C3.3 flare may have produced a Coronal Mass Ejection (CME), which potentially could have an Earth directed element. However, currently there is limited imagery available to verify this possibility.

Solar Wind / Geomagnetic Activity: The solar wind speed started the period slightly elevated close to 430 km/s, then declined to background levels through the day, before increasing slightly through the evening to end the period at slightly elevated levels again, around 410 km/s. The solar wind density was mainly at average levels, until the evening when a slight increase to become above average occurred. The phi angle was generally positive until the evening, then changed to become negative. The IMF was weak throughout, with an evening peak of 8 nT. The north-south component (Bz) was also weak, ranging between +5 and -5nT. The subtle changes in the solar wind environment indicated the possible arrival of a CIR from a high speed stream from CH61. However, geomagnetic activity remained Quiet (Kp 0-2) throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES 16 was at Normal Background levels. The high energy electron flux (greater than 2 MeV) was at background to moderate levels, peaking at 418 pfu at 03/1750 UTC. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold, although with an increasing trend later in the day. The 04/0000 UTC observation was 5.44e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low, with occasional C-class flares and a chance of M-class flares. No significant regions are expected to rotate onto the visible disc from the far side through the period.

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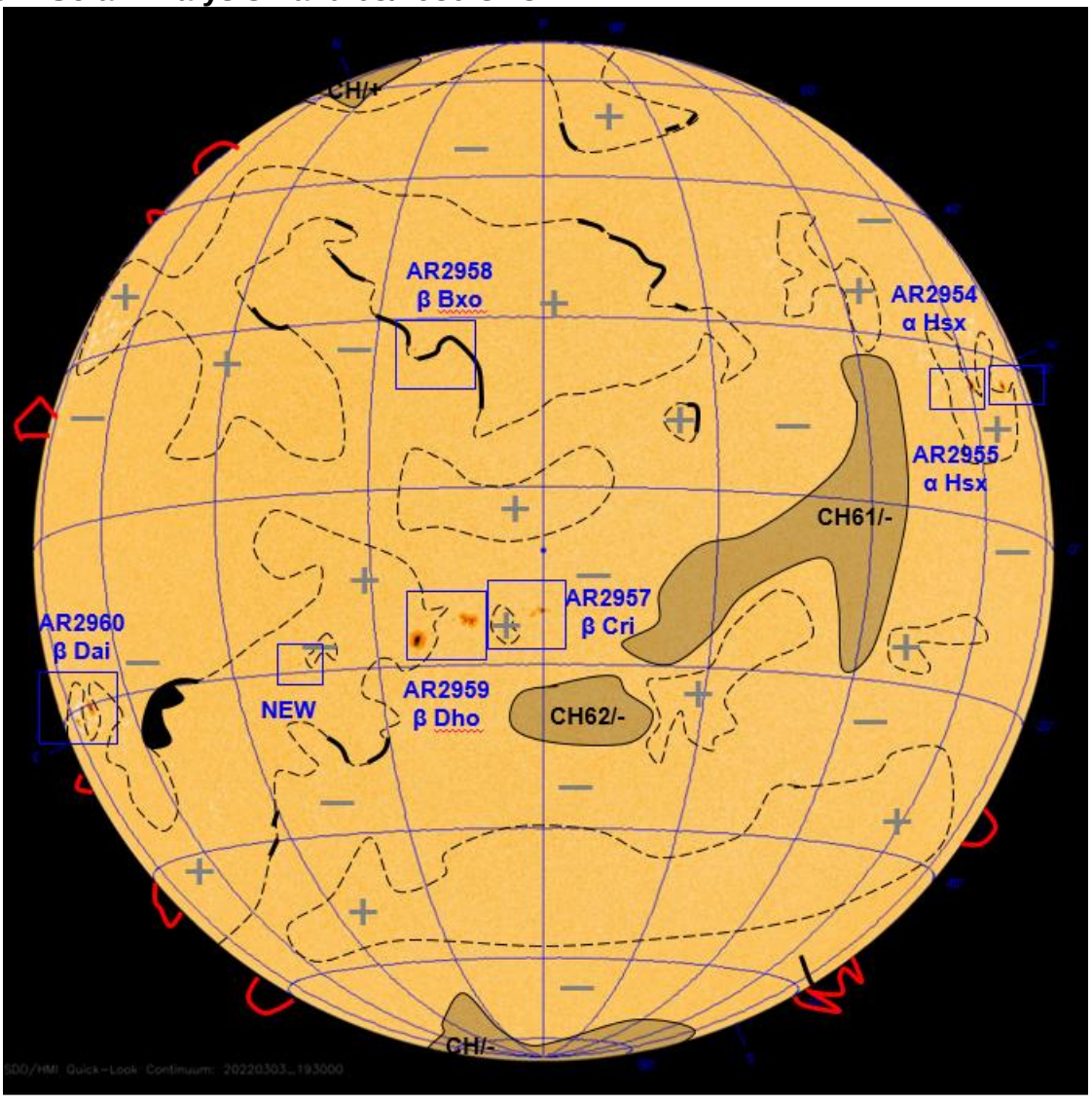
Solar Wind / Geomagnetic Activity: Through the period Earth is likely to experience a negative polarity high speed stream (HSS) from CH61, quickly followed by a HSS from CH62. A CME, emitted on 2nd March in association with the M-class flare, may brush Earth on day 3 (6th). Geomagnetic activity is expected to be Quiet to Unsettled at first (Kp 2-3), increasing Unsettled to Active (Kp 3-4) today and then at times through the rest of the period, with a chance of isolated G1/Minor geomagnetic storm (Kp 5) intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels.
The high energy electron flux and fluence is expected to remain at background to moderate levels today and tomorrow, then increasing to predominantly moderate levels, with occasional breaches of the high level (1000 pfu) possible at the peaks of the diurnal cycles, during days 3 and 4 (6th and 7th). However, confidence is low regarding this, as flux levels may be tempered by any CME arrival. The corresponding fluence is expected to show an increasing trend, whilst persisting below the Active (1e8 integrated flux) threshold.

Figure 1. Solar Analysis Valid 03/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two main aspects of the geomagnetic forecast - firstly a high speed stream (HSS) from CH61 quickly followed by a HSS CH62; and secondly possible marginal effects from the 02/1739UTC M2.0 CME that should mainly pass behind the Earth in the track of its orbit. Despite CH61/- and CH62/- being present on the previous rotation, a CME also occurred around 27 days ago which contaminated the persistence data. Looking at the westward leading edge of CH61 a HSS from this feature should be imminent, and recent subtle changes in the solar wind parameters indicate that a weak CIR may have arrived. It could be that the CH61 has connected to Earth, but only weakly at the moment, with a gradually increase possible, and with speeds potentially (eventually) reaching 450-500 km/s as indicated by STEREO-A data. Being near the vernal equinox, these negative coronal hole features make a G1/Minor geomagnetic storm possible.

Modelling of the 02/1739UTC M2.0 CME revealed some MOSWOC Enlil ensemble members with 'hits' on or after 06/1200UTC, however closer inspection of their perturbations suggests that these are not favoured scenarios (e.g. excessively wide CME cone angles - compared to observed imagery). In any case, with this CME thought to be more fully aimed at STEREO A. Therefore confidence is low regarding the possibly glancing blow of the CME at Earth on day 3 (6th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	30	40	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
2022-03-03 06:01 UTC	Possible partial	AR2958	NE quadrant, N05E039	270km/s	After 06/1200UTC	Mainly behind Earth in orbit, low confidence in glancing blow.

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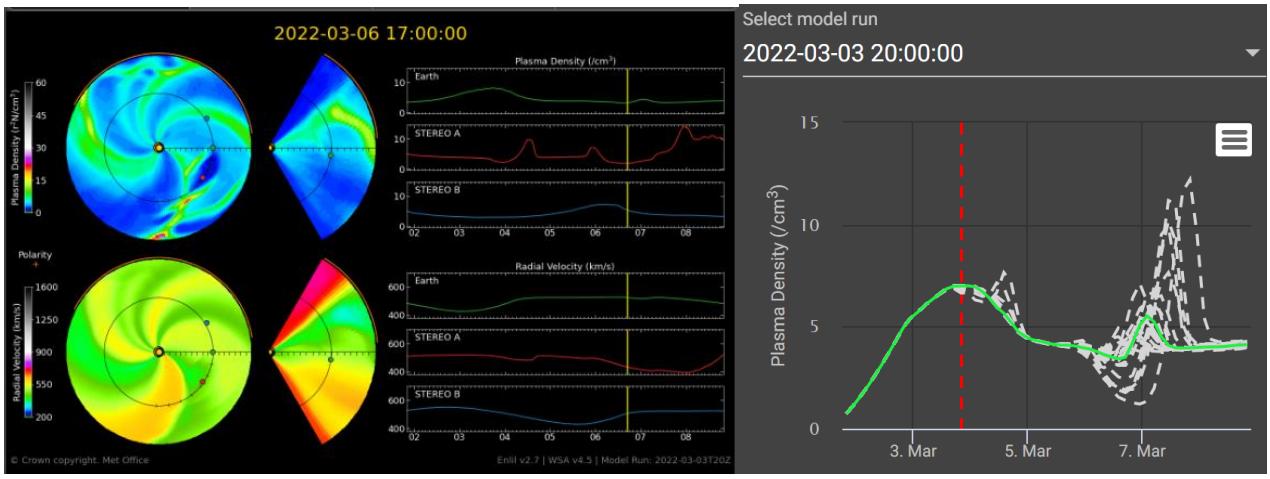
Figure 2: Enlil deterministic model (left) and Enlil ensemble runs (right) showing the potential glancing blow of a CME on 6th March.



Radio Blackouts - X-Ray Flares:

There are six numbered regions on the disc, along with a new and un-numbered small and simple Axx/alpha region in the southeast quadrant. AR2954 and 2955 remain simple, mature and stable Hsx/alpha nearing the western solar horizon. AR2957 Cri/beta has reduced slightly, losing some penumbra. AR2959 Dho/beta is currently classified as the largest region on the visible disc, but AR2960 Dai/beta is likely to replace AR2959 as the largest and most complex region on the visible disc, once analysis becomes easier as AR2960 rotates further onto the visible disc. In addition a plage region has rotated onto the northeast limb, with flux loops showing in AIA 171 imagery indicating some complexity and energy available, despite the lack of visible spots.

Solar activity has been Low over the past 24 hours, with the largest flare a C3.3 from AR2958. Despite AR2958's small and innocuous appearance this region remains the most likely to produce significant flares. However, AR2960 also has potential, as it is likely to be magnetically more complex than currently classified. Therefore, further C-Class flares are expected and there is a chance of M-Class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

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The high energy proton flux (10MeV) measured at GOES 16 is currently at background levels. The slightly increasing trend in the probabilities indicates the rotation of AR2958 and AR2960 further west across the visible disc, and so into slightly more geo-effective positions. However, overall the high energy proton flux (10MeV) is expected to remain at background levels.

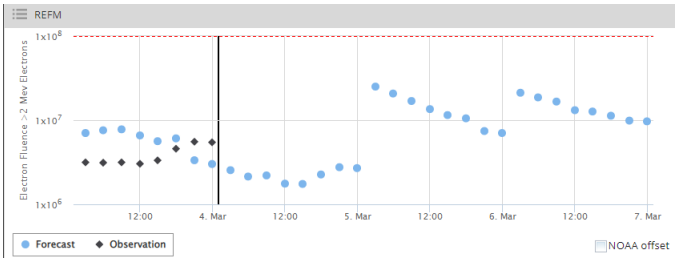
Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	3	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) has been at background to moderate levels during the past 24 hours, with background to slightly elevated solar wind speeds. Through much of the period HSS from coronal hole features are expected to reach Earth, maintaining slightly elevated winds for much of the time.
The high energy electron flux and fluence is expected to remain at background to moderate levels today and tomorrow, then increasing to predominantly moderate levels, with occasional breaches of the high level (1000 pfu) possible at the peaks of the diurnal cycles, during days 3 and 4 (6th and 7th). However, confidence is low regarding this, as flux levels may be tempered by any CME arrival. The corresponding fluence is expected to show an increasing trend, whilst persisting below the Active (1e8 integrated flux) threshold. The Met Office REFM model is therefore considered to be offering good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Met Office REFM model.



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